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Screening for arrhythmias in secondary school students' in Port Harcourt, Nigeria

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Abstract: *Introduction:*
Undetected arrhythmias are the most common cause of sudden cardiac deaths, and the prevalence of primary cardiac arrhythmias increases with age, being twice as common in adolescence as in younger children. The period of secondary school education is a time of participation in active and competitive sports by most adolescents. Since sudden cardiac death often occurs during physical activity of sporting event, it therefore becomes necessary to screen adolescence in secondary school for arrhythmia for purposes of early detection and risk profiling for intervention.
Methodology: A multi-staged sampling technique was employed to select 1002 adolescent from 18 secondary school in Port Harcourt. An investigator administered questionnaire was used to obtain relevant biodata and health information; physical examination, anthropometry and a 12-lead electrocardiogram (ECG) was subsequently performed and data analyzed.
Results: There were 595 males and 407 females (ratio of 1.5:1), age ranged from 10 to 19years.
Seventy-four (7.4%) were underweight, 52 (5.2%) overweight and 29 (2.9%) were obese. Majority of students (96.2%) had normal ECG – sinus rhythm and normal ECG variants (sinus arrhythmia, first degree heart block, incomplete right bundle branch block, AV nodal rhythm, wandering a trial pacemaker, ST segment elevation, premature atrial and ventricular contractions), while 38 (3.8%) had ECG with pathologic abnormalities.
The commonest ECG abnormality was prolonged QT interval which was seen in 18 students (47.4% of abnormalities).
Conclusion: Some secondary school students in Port Harcourt have potentially life-threatening arrhythmias. Regular screening of adolescents in secondary schools for risk profiling and early intervention is recommended.

Keywords: Arrhythmia, secondary school students, Port Harcourt

Introduction

The adolescent period is one of the physically active times of a child's life where participation in competitive sports in secondary schools occurs. Sudden Cardiac Deaths often occur during physical activity or sporting events[1]. Primary cardiac arrhythmias are probably ten times more common as a cause of sudden cardiac deaths compared to the other causes and their prevalence have been shown to rise with age[2]; with the prevalence in adolescents being twice as much as in younger children.[3] Sudden cardiac death of arrythmogenic etiology in children has been reported in hypertrophic cardiomyopathy, Long QT Syndrome (LQTS), Wolff-Parkinson-White syndrome (WPWS), complete heart block, ventricular arrhythmias, acquired heart diseases and post-cardiac surgery.[4] Arrhythmias may also occur in children with structurally normal heart and has been reported to occur in 0.02% to 5% of children[5-7] varying from benign sinus arrhythmia to life threatening arrhythmias such as ventricular tachycardia and bradycardia.[7]
Sinus tachycardia is by far the most commonly reported arrhythmia in children, followed by supraventricular tachycardia (SVT) which represents about 13%, and bradycardias, accounting for about 6% of cases.[7] Arrhythmias may also occur as side effects of medications used in the treatment of chronic conditions in children, including antiretroviral drugs like Lopinavir and Saquinavir which are associated with PR interval and QT interval prolongation respectively.[8,9] The major risk of arrhythmia is that it causes either severe tachycardia or bradycardia leading to decreased cardiac output; or it degenerates into more critical arrhythmias such as ventricular tachycardia and ventricular fibrillation which subsequently may lead to sudden death.[10]
Unexpected sudden death is a tragedy at any age, but is particularly so in childhood and adolescence. Some studies have been carried out on the prevalence of ar-

rhythmias in Nigerian children.[11,12,13] Seriki and Smith[11] in 1966 obtained a prevalence of 20% amongst university students in Lagos while Ogedengbe *et al*[12] in 2012 got a prevalence of 8% for left a trial enlargement.

The fundamental strategies for prevention of Sudden cardiac death include electrocardiographic screening of general population, risk profiling and interventions among patients with identified cardiac disease.[14] However, in Nigeria, there are limited measures in place to screen for and reduce the burden of sudden cardiac death, especially in children. Long term experience has provided evidence that systematic screening, with 12-lead ECG, after history and physical examination, is effective in identifying individuals with potentially lethal cardiovascular disease for early intervention, and saves lives.[15,16]

This study set about to determine the prevalence and types of arrhythmias in adolescents in secondary schools in Port Harcourt, using ECG as a screening tool. The findings have the potential to aid in the institution of cardiovascular health screening services for Nigerian children especially as an integral component of school health program.

Methods

The study was carried out in Port Harcourt Local Government Area (PHALGA) of Rivers State in Southern Nigeria from September to December 2014. Employing a multi-staged sampling technique, 1002 adolescent secondary school students aged 10 to 19 years were randomly selected from 55 secondary schools located within the three school districts of PHALGA. (Diobu, Township and Trans-Amadi) Students with known underlying cardiac and other chronic illnesses were excluded from the study. Ethical clearance was obtained from the Research and Ethics Committee of the University of Port Harcourt Teaching Hospital (UPTH) and permission obtained from the principals of selected schools. Informed consent and assent was obtained from parents and selected students respectively.

Sample size was calculated using the formula [17]

$N = \frac{z^2(pq)}{e^2}$

where N = minimum sample size

z = 1.96 at 95% confidence limits, so that $z^2 = 3.8416$

p = Prevalence of ECG abnormalities in adolescent school students. (50% was used as there are no documented data on the prevalence of abnormal ECG in adolescent Nigerian students).

$q = 1 - p$

e = error margin tolerated at 5% = 0.05

Allowance for Attrition of 20% was also added to the minimum sample size.

A structured investigator administered questionnaire was used to obtain relevant information from selected students including biodata, past medical history, drug history, family and social history, and review of the cardiovascular, respiratory, central nervous system, genitourinary and haematologic systems. Afterwards, weight and height measurements were taken and BMI calculated using the formula weight (kg) / height^2 (m^2). A general physical and cardiovascular examination was also performed. The BMI was subsequently plotted on the WHO BMI percentile chart for age and sex. Any BMI below the 5th percentile was regarded as underweight. BMI between the 5th and less than the 85th was regarded as normal, while BMI between the 85th percentile to less than the 95th percentile was regarded as overweight and BMI equal to or greater than the 95th percentile was regarded as obese.[18]

Blood Pressure was measured in accordance with the technique described by Moss,[19] and then a 12-lead ECG recording was done using a portable digital electrocardiograph in the standard way based on the American Heart Association specifications.[20] Measurement and interpretation of the heart rate, rhythm, cardiac axis, PR-interval, QRS duration and QTc interval was done by the investigators. The QT_c was calculated using the Bazzet's formula: QTc = QT/√RR interval[19]

Data Analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 software.

The following were determined from the data;

- Demographic pattern of the study population.
- ECG pattern in relation to BMI.
- Prevalence and types of abnormal ECGs in the study population, in relation to age, sex and BMI.

The student t- test and ANOVA were used for comparison of means, while chi square test was used for proportions. Statistical significance at 95% confidence interval was p-value <0.05.

All children who were found to have abnormal ECG patterns were referred to the Paediatric Cardiology Unit of UPTH for further cardiac evaluation.

Result

One thousand and sixty-six questionnaires were distributed to students selected from eighteen secondary schools. However, 15 of the students had known chronic illnesses (asthma and congenital heart disease) while forty-nine of them had signs suggestive of cardiovascular disease (pathologic murmur and elevated blood pressure for age). These students were excluded from the study. Thus data was analyzed for 1,002 of the recruited students, who met study inclusion criteria.

School distribution of the study

Six hundred and fifty-nine respondents (65.8%) were from private schools while 343 (34.2%) were from public schools, giving a ratio of 1.9:1. Of the 1,002 students,

324 (32.34%) were from Township district, 347 (34.63%) from Diobu and 331 students (33.03%) were from Trans-Amadi district, as shown in Table 1.

Table 1: School distribution of the study population

School district	Private school students	Public school students	Total (%)
Township	223	101	324 (32.34)
Diobu	227	120	347 (34.63)
Trans-Amadi	209	122	331 (33.03)
Total (%)	659 (65.8)	343 (34.2)	1,002 (100)

Age and sex distribution of the students

The age and sex distribution of the study population is shown in Table 2. The mean age of the study population was 15 ± 2 years, with a male to female ratio of 1.5:1.

Table 2: Age and sex distribution

Age group (years)	Sex Male (%)	Female (%)	Total (%)
10-14	322 (54.1)	154 (37.8)	476 (47.5)
15-19	273 (45.9)	253 (62.2)	526 (52.5)
Total	595 (59.4)	407 (40.6)	1,002(100%)

Weight distribution of the subjects by age and sex

The weight distribution of the student population is shown in Table 3. The weight ranged between 19 and 98.9kg, with a mean of 49.5 ± 11.4kg.

Table 3: Mean Weight (Kg) according to age and sex

Age-group	Mean weight (kg) (range)				
	Male	Female	Total	T-test	P-value
10-14 years	42.2±9.6 (19-98.6)	46.4±10.7 (22.5-76.8)	43.56±10.17	-4.117	0.000
15-19 years	55.7±9.8 (33.5-87.4)	53.8±9.3 (36-98.9)	54.80±9.62	2.365	0.018

Height distribution of the subjects by age and sex

The mean height of the students was 1.68 ± 0.31m (range–1.27 to 1.93m). This is illustrated in Table 4.

Table 4: Height (m) according to age and sex

Age groups	Mean height (m)(range)				
	Male	Female	Total	T-test	P-value
10-14 years	1.55±0.33 (1.27-1.85)	1.62±0.36 (1.30-1.70)	1.57±0.34	-1.959	0.051
15-19 years	1.78±0.19 (1.52-1.93)	1.79±0.27 (1.44-1.90)	1.78±0.23	-0.515	0.606

Body mass index of the subjects

The BMI of the students ranged between 11 and 39 kg/m^2 with a mean of 19.51 ± 3.05 kg/m^2. The mean BMI was seen to increase with increasing age in both males and females. The females however had a higher mean BMI compared to the males across all age groups. The overall mean BMI of the female subjects was significantly higher at 20.43 ± 3.42 Kg/m^2 compared to that of the males which was 18.89 ± 2.60 Kg/m^2 (p = 0.0001). This is illustrated in table 5.

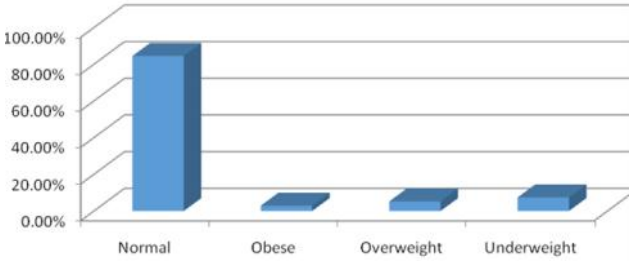
Table 5: Body mass index (Kg/m^2) according to age and sex

Age group	Mean BMI (kg/m^2)(range)				
	Male	Female	Total	T-test	P-value
10–14 years	17.90±2.58 (14.9-26.47)	19.43±3.32 (10.57-31.04)	18.40±2.92	-5.490	0.0001
15–19 years	19.88±2.61 (12.5-35.35)	21.42±3.52 (16.25-38.6)	20.62±3.17	-5.721	0.0001

BMI distribution of study population

Fig 1 illustrates the BMI distribution of the study population. Eight hundred and forty-seven (84.5%) of the students had a normal BMI, 74 (7.4%) were underweight, 52 (5.2%) overweight and 29 (2.9%) were obese.

Fig 1: Body mass index of students



ECG Rhythm and Conduction Patterns in the study population

Table 6 shows the ECG rhythms of the study population. Majority of the students (96.2%) had normal ECG – sinus rhythm and normal ECG variants (sinus arrhythmia, first degree heart block, incomplete right bundle branch block, AV nodal rhythm, wandering a trial pacemaker, ST segment elevation, premature a trial and ventricular contractions), while 38 (3.8%) had ECG abnormalities.

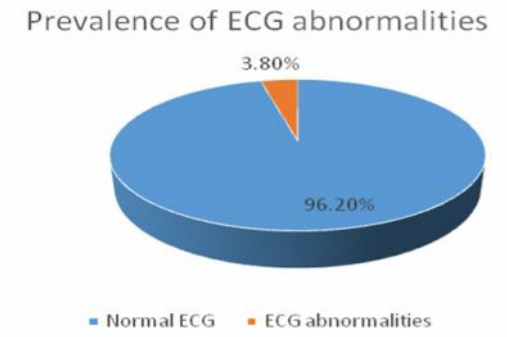
Table 6: ECG Rhythm and Conduction patterns of the study population

ECG finding	No of students	Percentage (%)
Sinus rhythm	805	80.3
Sinus arrhythmia	96	9.6
First degree heart block	19	1.9
Prolonged QTc interval	18	1.8
Right bundle branch block	11	1.1
Right a trial dilatation	11	1.1
AV nodal rhythm	10	1.0
Wandering a trial pacemaker	10	1.0
Premature ventricular contractions	7	0.7
Right ventricular hypertrophy	5	0.5
Premature a trial contractions	3	0.3
ST segment elevation	3	0.3
Left ventricular hypertrophy	2	0.2
Left a trial dilatation	1	0.1
First degree heart block and complete RBBB	1	0.1
Total	1002	100

Prevalence of ECG abnormalities in the study population

Of the 1002 students screened, 38 had ECG abnormalities, giving a prevalence of 3.8%. This is illustrated in Figure 2.

Fig 2: Prevalence of ECG abnormalities



Type specific prevalence of ECG abnormalities

Table 7 illustrates the type-specific prevalence of the ECG abnormalities seen. The commonest ECG abnormality in the study population was prolonged QT interval which was seen in 18 students (47.4% of abnormalities).

Table 7: Prevalence of ECG abnormalities

ECG Abnormality	No of students	Percentage (%)	Prevalence
Prolonged QTc interval	18	47.4	1.8
Right atrial dilatation	11	28.9	1.1
Right ventricular hypertrophy	5	13.2	0.5
Left ventricular hypertrophy	2	5.3	0.2
Left atrial dilatation	1	2.6	0.1
First degree heart block and Complete RBBB	1	2.6	0.1
Total	101	100	3.8

Distribution of ECG abnormalities according to age

ECG abnormalities were more common among the 15 to 19 years' age group, though the difference was not statistically significant, except for right atrial dilatation. Nine (81.8%) of the subjects with right atrial dilatation were in the 15-19 years' age group, and the difference in proportion (18.2%) in the 10-14-year age group was significant (p=0.05). This is shown in Table 8.

Distribution of ECG abnormalities according to sex

Table 9 shows that there was a higher frequency of all the ECG abnormalities (except left atrial hypertrophy) in the male students. All (100%) of the right a trial dilatation were seen among the male students; the difference was statistically significant.

Distribution of ECG abnormalities according to BMI

Right ventricular hypertrophy was significantly higher in obese adolescents as three (60%) of the 5 cases of right ventricular hypertrophy were found among the obese students (p=0.001). The only case of left atrial dilation was found in an overweight student. Normal weight children also had ECG abnormalities. Table X illustrates the distribution of the ECG abnormalities according to BMI.

Table 8: Age-group specific prevalence of ECG abnormalities

	Age groups						
	10 – 14 years		15 – 19 years		Total	χ^2	P-value
Abnormality	No (18)	%	No (20)	%			
Prolonged QTc interval	12	66.7	6	33.3	18	0.315	0.673
Right a trial dilatation	2	18.2	9	81.8	11	3.834	0.05*
Right ventricular hypertrophy	3	60.0	2	40.0	5	-	0.673+
Left ventricular hypertrophy	1	50.0	1	50.0	2	-	-
Left a trial dilatation	0	0.0	1	100.0	1	-	-
First degree heart block and Complete RBBB	0	0.0	1	100.0	1	-	-

*Significant value, + Fisher's exact test

Table 9: Sex prevalence of ECG abnormalities

	Sex						
	Male		Female		Total	χ^2	P-value
Abnormality	No (30)	%	No (8)	%			
Prolonged QTc interval	12	66.7	6	33.3	18	0.391	0.532
Right a trial dilatation	11	100.0	0	0.0	11	7.571	0.006*
RVH	4	80.0	1	20.0	5	-	0.328+
LVH	2	100.0	0	0.0	2	-	-
Left a trial dilatation	0	0.0	1	100.0	1	-	-
First degree heart block and Complete RBBB	1	100	0	0.0	1	-	-

*Significant value, + Fisher's exact
RVH – right ventricular hypertrophy
LVH – left ventricular hypertrophy

Table 10: Distribution of ECG abnormalities according to BMI

Abnormality	BMI STATUS Underweight Number (5)	%	Normal Number (27)	%	Underweight Number (1)	%	Obese Number (5)	%	Total	χ^2	P-value
Prolonged QTc interval	3	16.7	13	72.2	0	0.0	2	11.1	18	6.615	0.056+
RAD	2	18.2	9	81.8	0	0.0	0	0.0	11	2.029	0.493+
RVH	0	0.0	2	40.0	0	0.0	3	60.0	5	16.449	0.001*
LVH	0	0.0	2	100.0	0	0.0	0	0.0	2	-	-
Left a trial dilatation	0	0.0	0	0.0	1	100.0	0	0.0	1	-	-
First degree heart block & RBBB	0	0.0	1	100.0	0	0.0	0	0.0	1	-	-

*Significant value, + Fisher's exact

Discussion

From the study, 38 adolescent students had ECG abnormality give a prevalence of arrhythmias of 3.8%. This is comparable to the 3.4% obtained by Mayer *et al*[21] in Germany. However, Riddle *et al*[22] got a higher prevalence of 9.8% possibly because of their higher sample size as they studied 4,138 adolescents (aged 14-18 years). The most common abnormalities observed in this study included prolonged QTc interval (1.8%), right a trial dilatation (1.1%) and right ventricular hypertrophy (0.5%). These findings have also reported in other studies in Chicago and California by Marek *et al*,[23] and Riddle *et al*[22] respectively. On the contrary, other studies by Hevia*et al*[24] Grossman *et al*[25] reported T wave abnormalities and shortened PR interval as the common ECG abnormalities observed. The prevalence of 1.8% of prolonged QT interval obtained in this study was much higher than that obtained by Marek *et al*[23] and Riddle *et al*[22] who reported a prevalence of prolonged QT interval of 0.3% and 0.4% respectively among apparently healthy adolescents. The reason for these variations may be due to environmental and ethnic factors. It may also be due to the criteria used in the definition of prolonged QT interval. In this study, QTc above 0.45 in males and 0.46 in females was considered abnormal while the criteria used by Riddle *et al*[22] was >0.47 in both sexes.

Of specific importance is the finding of a case of complete RBBB, which has been considered in studies to be an essential ECG feature of Brugada syndrome-a clinical entity that causes sudden death from ventricular fibrillation.[26] Another subject had a prolonged QT interval of 0.5sec which is highly suggestive of long QT syndrome (LQTS), a condition also known to be associated with sudden death following torsade de pointe. The prognostic value of incidentally discovered RBBB and prolonged QT interval has important implications for cardiovascular risk assessment. It is difficult to categorically state that these subjects have these syndromes from an ECG obtained following a single screening test, thus, there is need to have follow up ECGs and other cardiac investigations to confirm the diagnosis; for which they were appropriately referred.

Sixty-three (6.3%) of the study population had normal ECG variants including: first heart degree heart block, incomplete RBBB, AV junctional rhythm, wandering a trial pacemaker, isolated premature ventricular complex, premature a trial complex and ST segment elevation. On the contrary, Seriki and Smith[11] obtained a higher prevalence as all 20% of the ECG abnormalities noted among the 302 Nigerian children and youths studied in 1966 were considered normal variants. The lower prevalence of the normal ECG variants in this present study may be due to the differences in the study population – as the Seriki[11] study had a higher proportion of younger children less than 10 years compared to this study.

Cross analysis of ECG abnormalities in relation to sex showed a significantly higher rate of abnormalities among the male subjects (p=0.006), similar to reports by other studies.[11,27,28] The abnormalities in this present study were three times more prevalent in males (3% versus 0.8% in the female subjects). These may require further evaluation, such as echocardiogram to eliminate intrinsic heart disease such as hypertrophic cardiomyopathy, which is commoner in males. Right a trial dilatation, for example, was significantly higher in the male students, with none of the 11 cases detected occurred in females. The higher prevalence of the ECG abnormalities in the male students may be as a result of the effect of testosterone on the heart and a different distribution of ion channels across the heart in males compared to females.[29,30]

Analysis of ECG abnormalities according to the age group showed that the overall prevalence of ECG abnormalities was higher among the older age group although this wasn't the case with some specific ECG abnormalities. Right a trial dilation was significantly higher among older adolescents aged 15-19 years while in the younger adolescents (i.e. 10-14 years), there was a higher proportion of prolonged QT interval. On the contrary, in other studies,[26,31] most ECG abnormalities were higher among the older age groups. This difference may be due to the fact that, this study population consisted of adolescents only, unlike the other studies which included younger children and older youths.[11]

As it relates to BMI, this study revealed a significantly higher prevalence of right ventricular hypertrophy among obese students; three (60%) of the five students with right ventricular hypertrophy seen were obese. This finding is important because it may suggest increased risk of heart disease in obese adolescents that may require risk profiling and intervention. Similar findings were obtained by Masaidi*et al*[32] in Italy, who also re-

ported an increased prevalence of right ventricular hypertrophy in obese patients.

All of the students who were detected to have arrhythmias were unaware of their condition as they were asymptomatic and had no suggestive history. The import of this cannot be overlooked as detected ECG abnormalities can mitigate sudden death by risk profiling affected adolescents for intervention. All the students detected to have arrhythmias and other ECG abnormalities in this study were referred to the Paediatric Cardiologistatthe University of Port Harcourt Teaching Hospital for further evaluation and follow up.

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